

Statement of Qualifications Indoor Air Quality Services

Clayton Environmental Consultants, Inc.
(Northeastern Operations,
Edison, New Jersey)

CONTENTS

<u>Section</u>	<u>Page</u>
1.0 INTRODUCTION	1
2.0 COMPANY PROFILE	1
3.0 IAQ CAPABILITIES AND EXPERIENCE	2
3.1 IAQ BUILDING DIAGNOSTIC EVALUATIONS	2
3.2 NONMICROBIAL IAQ SAMPLING EVALUATIONS	3
3.3 HVAC EVALUATIONS	4
3.4 LEGIONELLA SAMPLING EVALUATIONS	4
3.5 MICROBIAL SAMPLING EVALUATIONS	5
4.0 IAQ-RELATED LABORATORY QUALIFICATIONS	5
5.0 PERSONNEL QUALIFICATIONS	6

Appendixes

- A CLAYTON ACCREDITATIONS, CERTIFICATIONS, AND LICENSES**
- B SELECTED RESUMES**

1.0 INTRODUCTION

This statement of qualifications presents information on indoor air quality (IAQ) services provided by Clayton Environmental Consultants, Inc. Clayton has been helping its clients solve environmental problems for over 35 years. We have provided environmental services to more than 3,000 clients, both large and small. Based upon the most recent Fortune Directory of the 500 Largest Industrial Corporations, last year alone, Clayton provided environmental services to nine of the top 10 firms, 23 of the top 25 firms, and 38 of the top 50 firms.

With an international staff of more than 400 professionals, including indoor air quality specialists, industrial hygienists, engineers, environmental scientists, and chemists, we offer a wide range of interdisciplinary skills and abilities to help our clients deal with their environmental issues.

2.0 COMPANY PROFILE

Founded in Michigan in 1954, Clayton is widely recognized as a leader in the fields of indoor air quality, industrial hygiene, asbestos management, environmental engineering, pollution control, and occupational health and safety. We have more than three decades of experience in conducting environmental assessments, sampling, and laboratory analysis for hazardous substances, as well as in interpreting environmental regulations. Clayton provides services to industrial, commercial, and governmental clients and is staffed and equipped to perform projects ranging in size from small, single-facility assessments to large, multidisciplinary remediation and monitoring programs.

Clayton distinguishes itself from other environmental organizations not only in its lengthy and dedicated history of professionalism, but in the unique structure of the company as well. Our professionals manage projects from well-staffed offices and laboratories throughout the United States, Canada, and the United Kingdom and, for special assignments, on location in Europe and the Far East. This gives us the flexibility to draw from our pool of technical experts from any of these locations. Our experts regularly consult together on a company-wide basis, so that complex and large projects receive attention from the most qualified professionals on a national, and, if necessary, international basis.

Our offices are located in or near the following major metropolitan areas:

- Detroit, Michigan
- New York City/Newark, New Jersey
- Atlanta, Georgia
- San Francisco, California
- Los Angeles, California
- Washington, D.C.
- Honolulu, Hawaii
- Windsor, Ontario, Canada
- Toronto, Ontario, Canada
- Birmingham, England
- Southampton, England
- London, England
- Gateshead, England

We offer our clients environmental services in five broad categories:

- IAQ services
- Industrial hygiene
- Asbestos management
- Environmental engineering
- Laboratory analysis

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This statement of qualifications includes the following information:

- IAQ capabilities and experience
- IAQ-related laboratory qualifications
- Personnel qualifications
- Relevant project experience

3.0 IAQ CAPABILITIES AND EXPERIENCE

Clayton is recognized as one of the oldest and most qualified consulting firms in the U.S., with many years of experience in providing a wide variety of IAQ services. During the past 3 years, we have conducted a wide variety of IAQ evaluations in hundreds of commercial, institutional, and healthcare facilities. Clayton's services have included air sampling for microorganisms, volatile organic compounds (VOCs), combustion products, inorganic acids and other air contaminants, water sampling for Legionella and other microorganisms, and evaluation of heating, ventilating, and air-conditioning (HVAC) systems.

There are currently no regulatory standards for indoor air quality. In the absence of regulations, professional society guidelines and protocols are generally accepted as state-of-the-art standards. Clayton's IAQ services conform to the consensus guidelines and protocols of national and international professional organizations such as American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE), American Industrial Hygiene Association (AIHA), American Conference of Governmental Industrial Hygienists (ACGIH), American Society for Testing and Materials (ASTM), the United States Environmental Protection Agency (USEPA), the World Health Organization (WHO), and the European Community.

Guidance from Clayton on IAQ protocols offers the employer the opportunity to minimize productivity loss associated with sick-building syndrome and building-related illness. Our IAQ group provides the following services to clients:

- General IAQ Evaluations
- Nonmicrobial IAQ Sampling Evaluations
- HVAC Evaluations
- Legionella Sampling Evaluations
- Microbial Sampling Evaluations

The following sections describe our experience in each area of specialization.

3.1 IAQ BUILDING DIAGNOSTIC EVALUATIONS

There are approximately 4 million nonindustrial commercial buildings in the United States. Experts currently estimate that approximately 30 percent of these buildings have IAQ problems and occupants of these facilities have symptoms of sick-building syndrome. Sick-building syndrome is judged to be present in buildings where significant numbers of occupants (generally greater than 20 percent) report nonspecific, primarily sensory complaints such as eye, nose, and throat irritation, fatigue, headache, mild neurotoxic symptoms (e.g., difficulty in concentration), and odor annoyance. Building-related illness occurs in a smaller subset of buildings and is characterized by the presence of clinically

recognizable diseases among occupants such as humidifier fever, asthma, and hypersensitivity pneumonitis.

The causes of IAQ problems are usually not obvious. Trial and error sampling and analysis of building air without the knowledge of the exact source of indoor air contaminants is costly and often does not resolve the building problem. An IAQ evaluation emphasizing an understanding of building diagnostics is a more practical and cost-effective approach to problem-solving.

Clayton has conducted hundreds of *extensive* IAQ evaluations for clients in commercial and industrial facilities, hospitals, schools, universities, health-care organizations, and governmental buildings. We offer both reactive and proactive IAQ evaluations.

Our *reactive* evaluations are provided in response to occupant complaints including those associated with sick-building syndrome and building-related illness. Even when there are no complaints, it is prudent to conduct preventive *proactive* IAQ evaluations to improve energy efficiency and indoor air quality in buildings, thereby improving occupant productivity and satisfaction. A proactive survey also provides defensible documentation of building conditions should litigation ever occur.

Our IAQ evaluations usually include a diagnostic approach involving the following:

- Review of ventilation system design and operating procedures for compliance with ASHRAE Standard 62-1989 *Ventilation for Acceptable Indoor Air Quality*.
- Review of ventilation system preventative maintenance program and inspection of the condition of system components including air filters, condensate drain pans, cooling coils, and humidifiers.
- Performance of direct-reading measurements including respirable particulate, carbon dioxide, temperature, and relative humidity. Results are compared with the recommendations of ASHRAE Standard 55-1981R *Thermal Environmental Conditions for Human Occupancy* and Standard 62-1989 *Ventilation for Acceptable Indoor Air Quality*.
- Inspection for microbiological reservoirs and amplifiers as well as sources of odors, chemical contaminants (e.g., volatile organic compounds [VOCs]), and combustion products.
- Preparation of a report summarizing observations and conclusions made during the evaluation as well as specific recommendations for corrective actions.

Sometimes, however, an IAQ evaluation may reveal active or potential contaminant sources such as VOCs and combustion products. In such cases, we may conduct subsequent air sampling and analysis to document the extent of contamination.

3.2 NONMICROBIAL IAQ SAMPLING EVALUATIONS

Frequently, it is necessary to document the concentration of certain kinds of air contaminants that may be present in indoor air. In such situations, an IAQ sampling evaluation is useful. Additionally, an IAQ sampling evaluation is a way to record that

certain baseline guidelines are being met on a company-wide basis. We have performed customized IAQ sampling evaluations for a variety of air contaminants including:

- VOCs, from sources such as construction materials and office furnishings or from interior processes such as printing operations
- Combustion product emissions, from sources such as motor vehicles and building chimneys or flues
- Pesticides

3.3 HVAC EVALUATIONS

HVAC system deficiencies are almost always associated with IAQ problems. These deficiencies can occur in the design, maintenance, and operation of the HVAC systems. Our extensive experience with HVAC systems indicates that operational problems occur in 70 percent of the buildings we evaluate, maintenance problems in 75 percent of the buildings, and design deficiencies in 47 percent of the buildings.

Our HVAC evaluation begins with a thorough inspection of the air-handling system that serves the occupied spaces. Our HVAC inspection includes evaluating the:

- Condition and maintenance of air filters, cooling coil condensate drain pans, and humidifiers
- Operation of the outdoor air intake system
- Effectiveness of the air delivery system in the occupied spaces
- Sources of contamination of the outdoor ventilation air entering the building such as cooling towers, exhaust fan outlets, plumbing vents, flues, and motor vehicles

Since the HVAC system is almost always a major source of IAQ problems, our recommendations emphasize modifications to the HVAC system's design, maintenance, and operation when necessary.

3.4 LEGIONELLA SAMPLING EVALUATIONS

Legionnaire's disease continues to be a major concern in North America and the United Kingdom. However, the risks of an outbreak of this disease can be minimized by adopting an effective management strategy for a building's service water systems which can be a major source of Legionella bacteria. An effective water management strategy not only reduces the likelihood of Legionnaire's disease, but also minimizes the operating and maintenance costs of water cooling, heating, and air-conditioning systems and improves their performance. Clayton annually conducts dozens of Legionella evaluations in offices as well as healthcare and industrial facilities.

Our Legionella evaluations are very focused and include four key components: risk identification and assessment, establishment of performance standards, development and implementation of control measures, and management review.

Risk Identification and Assessment. In this phase, we conduct a critical appraisal of all service water systems to identify the potential sources of *Legionella*. Our appraisal includes a comprehensive survey of each water system and its ancillary equipment, including water storage tanks, distribution pipework and fittings, heating, cooling, and air-conditioning plant, beverage vending machines, and showers. In addition, we perform sampling and analysis of water and accumulated solids at our accredited laboratories as well as a review of operating and maintenance practices. This information is essential in developing a realistic estimate of the risk associated with each water system.

Establishment of Performance Standards. Once risks are assessed, we establish performance standards for service water systems and cooling towers to minimize these risks. We tailor performance standards to each client facility.

Development and Implementation of Control Measures. It is impractical to eliminate *Legionella* from most service water systems. Therefore, control measures are essential. We customize control measures to the individual requirements of each water system. Most *Legionella* outbreaks are a result of poor control measures and inadequate documentation.

Management Review. This last component is critical to the success of a *Legionella* risk management program. As part of the review, we evaluate the technical performance of the control measures, reassess the risks associated with new systems or changes in operation, and revise standards of performance and control programs as necessary.

3.5 MICROBIAL SAMPLING EVALUATIONS

Clayton has conducted non-*Legionella* microbial investigations at a variety of facilities including industrial, healthcare, and office buildings as well as facilities that have experienced water disasters and fires resulting in water damage. Microbial contamination in critical care facilities can result in hospital-acquired infection, especially among patients with compromised immune systems. Fungal and bacterial proliferation may occur in buildings with excessive moisture in the occupied spaces or HVAC system.

We examine special microbial sources such as water spray systems, humidifiers, fancoil units, porous insulation in HVAC systems, and water-damaged occupied spaces. We conduct indoor and outdoor sampling of these sources using a wide variety of sophisticated instrumentation to determine the concentration and kinds of airborne fungi and bacteria. Based on the results of our investigation, we develop remedial plans to control or eliminate microbial contamination.

4.0 IAQ-RELATED LABORATORY QUALIFICATIONS

Laboratory analysis is an important element in the assessment and control of IAQ problems. Analytical results must be reliable to provide an accurate characterization of the environment sampled and be defensible in a court of law. Thus, the integrity of the entire chain of events, from sampling in the field to providing laboratory results to clients, must be carefully documented and protected. In particular, the quality of the laboratory data depends upon the expertise of the staff, quality control measures, instrumentation, and recognized accreditation.

Clayton offers its clients the assurance of reliability and accuracy based on more than 30 years of laboratory experience. Our laboratories have gained this competence by

successfully completing many varied and difficult analytical projects, developing new analytical methods, and instituting several quality control and quality assurance programs. Moreover, we offer prompt turnaround time at competitive laboratory rates. Clayton serves its clients from well-equipped and well-staffed laboratories in Michigan, Georgia, New Jersey, California, Canada, and the United Kingdom.

Our laboratories routinely identify IAQ pollutants including VOCs, nicotine, pesticides, and combustion products, using the following techniques:

- Gas chromatography (GC)
- Gas chromatography/mass spectrometry (GC/MS)
- Inductively coupled argon plasma (ICAP) spectrophotometry
- High performance liquid chromatography (HPLC)
- Ion chromatography
- X-ray diffraction (XRD)
- Transmission electron microscopy (TEM)

Our analytical capabilities and experience in the use of these instruments in our laboratories makes Clayton one of the largest IAQ laboratory networks in North America and enables us to achieve levels of analytical sensitivity at or below those reported by WHO, ASHRAE, and the National Ambient Air Quality Standard guidelines. Our laboratories are accredited by the AIHA and participate in the AIHA Proficiency Analytical Testing (PAT) program. The Novi, Michigan, laboratory is used by USEPA under its contract laboratory program (CLP) for organic analysis. For a complete list of Clayton's accreditations, see Appendix A.

5.0 PERSONNEL QUALIFICATIONS

Helping clients evaluate and solve IAQ problems in the workplace requires a team with knowledge, skill, and experience. Clayton's staff of more than 400 includes over 100 specialists in HVAC engineering, microbiology, and industrial hygiene who provide extensive, specialized services. Because of this large staff, Clayton can perform numerous projects at the same time, with multiple staff members dedicated to a single project, and can respond to emergency situations on short notice.

Our professionals are highly qualified with considerable training to perform indoor air evaluations, ventilation system analysis, microbiological assessments, exposure monitoring and analysis, program development, and regulatory compliance assessment and training. Staff credentials also include professional engineering licensure and safety professional certification.

Human resource development at Clayton includes hands-on training, continuing education, and interactive performance reviews. Our professionals keep abreast of the most current trends, concerns, and methodologies by regularly attending training seminars in their area of specialty.

Appendix B presents selected resumes of Clayton IAQ professionals.

APPENDIX A

CLAYTON ACCREDITATIONS, CERTIFICATIONS, AND LICENSES

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Clayton
ENVIRONMENTAL
CONSULTANTS

Clayton Accreditations, Certifications, and Licenses

Agency, Program, and Clayton Location	Proficiency Testing Participant Number	Issue Number	Date Issued
NATIONAL PROGRAMS			
AMERICAN INDUSTRIAL HYGIENE ASSOCIATION (AIHA)			
- Accredited Industrial Hygiene Laboratory			
Edison	07083-001	29	12/1/74
Kennesaw	30067-001	362	4/1/88
Novi	48075-001	18	6/1/74
Pleasanton	94566-002	347	11/1/87
Windsor	CN302-001	247	3/1/84
- Registered Asbestos Analysts Registry (AAR) Personnel			
Cypress/Honolulu	90630-003	-	-
Edison	07083-001	-	-
Kennesaw	30067-001	-	-
Novi	48075-001	-	-
Pleasanton	94566-002	-	-
Windsor/Toronto	00302-001	-	-
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY/NATIONAL VOLUNTARY LABORATORY ACCREDITATION PROGRAM (NIST/NVLAP)			
- Accredited Airborne Asbestos Laboratory (TEM)			
Kennesaw	-	1125-00	7/30/90
- Accredited Bulk Asbestos Laboratory (PLM)			
Edison	-	1125-02	6/8/89
Kennesaw	-	1125-00	4/1/89
Novi	-	1125-01	6/8/89
Pleasanton	-	1125-03	6/8/89
U.S. ENVIRONMENTAL PROTECTION AGENCY (USEPA)			
- Approved Organics Contract (CLP) Laboratory			
Novi	-	68-D1-0087	7/15/91
STATE PROGRAMS			
CALIFORNIA DEPARTMENT OF HEALTH SERVICES (DHS)			
- Accredited Environmental Laboratory			
Pleasanton	CA047	1196	5/23/90
- Approved Hazardous Waste Contract Laboratory			
Pleasanton	-	89-97119	7/1/89
CONNECTICUT, STATE OF			
- Approved Public Health Laboratory			
Kennesaw (Asbestos)	-	PH-0731	6/15/90
KANSAS DEPARTMENT OF HEALTH AND ENVIRONMENT (KDHE)			
- Certified Drinking Water and Pollution Control Laboratory			
Pleasanton	CA047	E-169	5/1/90
- Certified Solid/Hazardous Waste Laboratory			
Pleasanton	-	E-1146	5/1/90
NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP)			
- Certified Drinking Water and Water Pollution Laboratory			
Edison	NJ223	12390	6/30/84
NEW YORK STATE DEPARTMENT OF HEALTH			
- Certified Environmental Laboratory			
Edison (Fibers by PCM)	10963	6096	4/4/90
(Asbestos by PLM)	10963	6097	4/4/90

(This summary does not include the accreditations, certifications, or licenses of Clayton Environmental Consultants, Ltd. [U.K.])

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Clayton National Accreditations and Certifications*

Agency, Program, and Clayton Location	Current Number	Date First Awarded
American Industrial Hygiene Association (AIHA)		
• Accredited Industrial Hygiene Laboratory		
--Edison	29	12/1/74
--Kennesaw	362	4/1/88
--Novi	18	6/1/74
--Pleasanton	347	11/1/87
--Windsor	247	3/1/84
• Approved Asbestos Analysts Registry (AAR) Personnel		
--Cypress/Honolulu/Phoenix	NA	12/1/87
--Edison	NA	7/20/87
--Kennesaw	NA	12/1/87
--Novi	NA	7/20/87
--Pleasanton	NA	7/20/87
Canadian Association for Environmental Analytical Laboratories (CAEAL)		
• Certified Environmental Analytical Laboratory		
--Windsor	1351	1/7/92
National Institute of Standards and Technology/ National Voluntary Laboratory Accreditation Program (NIST/NVLAP)		
• Accredited Airborne Asbestos Laboratory (TEM)		
--Kennesaw	1125-00	6/8/89
• Accredited Bulk Asbestos Laboratory (PLM)		
--Edison	1125-02	6/8/89
--Kennesaw	1125-00	4/1/89
--Novi	1125-01	6/8/89
--Pleasanton	1125-03	6/8/89
National Measurement Accreditation Scheme (NAMAS)		
• Accredited Laboratory		
--Birmingham	389	6/87
--London	732	10/89
--Southampton	520	12/87
U.S. Air Force		
• Approved Contract Laboratory		
--Novi	F33615-90-D-4003	8/14/85
U.S. Army Corps of Engineers (USACE), Missouri River Division		
• Validated Laboratory		
--Novi	NA	1/27/89
--Pleasanton	NA	5/25/92
U.S. Environmental Protection Agency (USEPA)		
• Approved RAS Organics Contract (CLP) Laboratory		
--Novi	68-D1-0087	3/11/85
• Approved SAS Contract (CLP) Laboratory		
--Novi	68-D9-0135	8/1/91
--Pleasanton	68-D9-0135	4/3/92

*Most accreditations are for specific tests registered with each organization.

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NA: Information not available or not applicable.

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Clayton State/Provincial Accreditations and Certifications*

Agency, Program, Clayton Location and Area of Testing	Current Number	Date First Awarded
Association of the Chemical Profession of Ontario (ACPO)		
• Certified Analytical Personnel –Windsor (Industrial Hygiene)	NA	(pending)
California Department of Health Services (DHS)		
• Certified/Registered Environmental Laboratory –Pleasanton (Hazardous Waste, Bulk Asbestos, Wastewater, and Drinking Water)	1196	6/30/86
Connecticut Department of Health Services (DHS)		
• Approved Public Health Laboratory –Kennesaw (Asbestos)	PH-0731	6/15/90
Michigan Department of Public Health (DPH)		
• Certified Drinking Water Laboratory –Novi	9004	2/12/92
New Jersey Department of Environmental Protection (DEP)		
• Certified Drinking Water and Water Pollution Laboratory –Edison	12390	6/30/84
New York State Department of Health (DOH)		
• Certified Environmental Laboratory		
–Edison (Non-potable Water)	10963-09927	4/4/90
(Potable Water)	10963-09928	4/4/90
(Air and Emissions)	10963-09929	4/4/90
(Solid and Hazardous Waste)	10963-09930	4/4/90
Ontario Ministry of the Environment (MOE)		
• Qualified Municipal/Industrial Strategy for Abatement (MISA) Laboratory –Windsor	-	-

*Most accreditations are for specific tests registered with each organization.

(1/19/93)

NA: Information not available or not applicable.

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APPENDIX B
SELECTED RESUMES

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Philip R. Morey, Ph.D., C.I.H.
Technical Director, Indoor Air Quality

EMPLOYMENT AND EXPERIENCE

Clayton Environmental Consultants, Inc., Edison, New Jersey
Technical Director, Indoor Air Quality, Environmental Health Services
September 1987 to Present

Honeywell Indoor Air Quality Diagnostics, Golden Valley, Minnesota
Senior Environmental Hygienist
1986 to 1987

National Institute for Occupational Safety and Health (NIOSH),
Division of Respiratory Disease Studies, Morgantown, West Virginia
Microbiologist and Senior Industrial Hygienist
1981 to 1987

Texas Tech University, Lubbock, Texas
Professor (1976 to 1981) and Associate Professor (1971 to 1975) of Biological Sciences

Dr. Morey provides leadership to all Clayton offices and to professional and governmental organizations at the national and international levels on technical aspects of indoor air quality topics. He has written several books and hundreds of articles and co-authored and contributed to numerous publications.

Dr. Morey has conducted several hundred indoor air quality evaluations since 1981; most of these focus on ventilation systems and sampling for airborne microorganisms. He is responsible for protocol development for indoor air quality evaluations, project management, coordinating and conducting field activities, report and proposal preparation, and technical review. Dr. Morey contributes to technical conferences by serving on and chairing technical committees, presenting numerous papers, and conducting many seminars.

EDUCATION

Ph.D., Biology, 1967
Yale University
New Haven, Connecticut

M.S., Biology, 1964
Yale University

B.S., Biology, 1962
University of Dayton
Dayton, Ohio

PROFESSIONAL REGISTRATION/CERTIFICATION

Certified in the Comprehensive Practice of Industrial Hygiene, American Board of Industrial Hygiene (ABIH), Certification No. 2047

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PROFESSIONAL AFFILIATIONS

International Society of Indoor Air Quality and Climate (Founding Member)
American Society for Testing and Materials (ASTM)
Chair, D-22.05 Technical Committee on Bioaerosols, 1987 to present.
Co-Chair, ASTM Conference on Biological Aerosols, Boulder, Colorado, July 1989
5th International Conference on Indoor Air Quality and Climate, International Advisor
American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE)
Member Research and Technology Committee, 1988 to 1992
Member Environmental Health Committee, 1985 to 1991
Member Indoor Air Quality Planning Committees for 1986, 1989, and 1993 Conferences
Member SSPC 62 (Ventilation for Acceptable Indoor Air Quality - Standard 62 Revision Committee)
American Industrial Hygiene Association
American Conference of Governmental Industrial Hygienists (ACGIH) (affiliate), charter member of Bioaerosols Committee, 1985 to present
American Academy of Industrial Hygiene
Sigma Xi
Editorial Advisor, Indoor Air-International Journal of Indoor Air Quality and Climate
Editorial Review Panel, INvironment-The Newsletter of Building Management and Indoor Air Quality
Committee on the Health Effects of Indoor Allergens, Institute of Medicine, National Academy of Sciences, Washington, D.C., 1991 to 1993

HONORS/AWARDS

Best Speaker Award, March 1984, ACGIH Symposium on Evaluating Office Environmental Problems, Atlanta, Georgia

PUBLICATIONS

"Use of Hazard Communication Standard and General Duty Clause during Remediation of Fungal Contamination," *The Sixth International Conference on Indoor Air Quality and Climate*, Helsinki, Finland (in press).

"Microbiological Events after a Fire in a High-Rise Building," *The Sixth International Conference on Indoor Air Quality and Climate*, Helsinki, Finland (in press).

"Botanical and Microbiological Contaminants of Cotton Fiber: Early Investigations," *Cotton and Microorganisms*, Eds. J.J. Fischer and L.N. Dolelsmith (in press).

"Microbiological Contamination in Buildings: Precautions during Remediation Activities," *IAQ '92 Environments for People*, pp. 94-100, 1992.

With J. Singh, "Indoor Air Quality in Nonindustrial Occupational Environments," *Part's Industrial Hygiene and Toxicology*, Part A, pp. 531-594, Eds. G. and F. Clayton, 4th Edition, John Wiley and Sons Inc., New York, 1991.

With C.M. Williams, "Is Porous Insulation Inside a HVAC System Compatible with a Healthy Building?" *IAQ '91 Healthy Buildings*, pp. 128-135, 1991.

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"Managing the Costs of Building-Related Employee Illness," *Viewpoints - The Marsh & McLennan Quarterly*, 20(3), 7-13, 1991.

"Bioaerosols in the Indoor Environment: Current Practices and Approaches," D.M. Weeks and R.B. Gammage, Eds., *The Practitioner's Approach to Indoor Air Quality Investigations*, American Industrial Hygiene Association, Akron, Ohio, pp. 51-72, 1990.

"Internal HVAC Pollution," *Pilot Study on Indoor Air Quality: Energy and Building Sciences in Indoor Air Quality*, NATO Committee on the Challenges of Modern Society, Saint-Adele, Quebec, pp. 47-55, 1990.

With J.C. Feeley, Sr., and J.A. Otten, Eds., "*Biological Contaminants in Indoor Environments*," ASTM STP 1071, ASTM, Philadelphia, PA, p. 244, 1990.

With J.C. Feeley, Sr., "The Landlord, Tenant, and Investigator: Their Needs, Concerns, and Viewpoints," P.R., Morey, J.C. Feeley, Sr., and J.A. Otten, Eds., *Biological Contaminants in Indoor Environments*, ASTM, STP 1071, pp. 1-20, 1990.

With J.C. Feeley, Sr., "Two Consultants' Views of Tomorrow," P.R. Morey, J.C. Feeley, Sr., and J.A. Otten, Eds., *Biological Contaminants in Indoor Environments*, ASTM, STP 1071, pp. 221-227, 1990.

With D. MacPhaul, "Rank Order Assessment of Volatile Organic Compounds in Indoor Air Quality Evaluations," *The Fifth International Conference on Indoor Air Quality and Climate*, Toronto, 2, pp. 735-739, 1990.

With C. Williams, "Porous Insulation in Buildings: A Potential Source of Microorganisms," *The Fifth International Conference on Indoor Air Quality and Climate*, Toronto, 4, 529-533, 1990.

With D.E. Shattuck, "Role of Ventilation Systems in the Causation of Building-Associated Illness," *Occupational Medicine State of the Art Reviews*, 4, pp. 625-642, 1989.

With B.A. Jenkins, "What Are Typical Concentrations Of Fungi, Total Volatile Organic Compounds And Nitrogen Dioxide In An Office Environment?" *ASHRAE Indoor Air Quality 1989*, pp. 67-71, 1989.

"Microorganisms in Buildings and HVAC Systems: A Summary of 21 Environmental Studies," *ASHRAE Indoor Air Quality 1988*, pp. 10-24, 1988.

With J.C. Feeley, "Microbiological Aerosols Indoors," *ASTM Standardization News*, 16, 54-58, 1988.

"Experience on the Contribution of Structure to Environmental Pollution," *Architectural Design and Microbial Pollution*, Ed. Ruth B. Kundsinn, Oxford University Press, pp. 40-80, 1988.

With M.J. Hodgson, W.G. Sorenson, G.J. Kullman, W.W. Rhodes, and G.S. Visvesvara, "Environmental Studies in Moldy Office Buildings," *ASHRAE Transactions*, 92(1): 399-419, 1986.

(1/26/93)

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Douglas E. Shattuck, P.E.
Manager
Indoor Air Quality

EMPLOYMENT AND EXPERIENCE

Clayton Environmental Consultants, Inc., Edison, New Jersey
Manager, Indoor Air Quality, Environmental Health Services
June 1988 to Present

Independent Engineering Consultant
Professional Engineer
January 1987 to June 1988

A.J. Celiano, Inc., Cranford, New Jersey
Engineering Manager, Design/Build Contracting
January 1979 to January 1987

Prudential Life Insurance Co., Newark, New Jersey
Associate Manager, Buildings Department
June 1970 to December 1978

Mr. Shattuck is a licensed professional engineer with broadbased mechanical engineering experience as a consultant, contractor, and corporate engineer. He has a thorough knowledge of ASHRAE guidelines and BOCA building codes. He has designed HVAC systems for hundreds of commercial buildings, including high-rise office buildings. He has also performed building diagnostics to determine the impact of HVAC systems' design, construction, and maintenance on indoor air quality.

Mr. Shattuck supervises a team of engineers, microbiologists, and industrial hygienists who perform indoor air quality and water quality evaluations. He develops procedures and protocols for other Clayton professionals and provides guidance to all Clayton offices.

EDUCATION

BSME, Mechanical Engineering, 1970
New Jersey Institute of Technology
Newark, New Jersey

PROFESSIONAL AFFILIATIONS

ASHRAE and ASTM

PUBLICATIONS

Walkthrough Indoor Air Quality Evaluations. Michigan's Occupational Health, 27, No. 1, Spring 1991.

Can Variable Air Volume Systems Be Compatible with Good Indoor Air Quality? The 5th International Conference on Indoor Air Quality and Climate, Toronto, Ontario, Canada, July 1990.

With P.R. Morey, *Role of Ventilation in the Causation of Building-Associated Illnesses.* Occupational Medicine, State of the Art Reviews, Problem Buildings: Building-Associated Illness and the Sick Building Syndrome, 1989, pp. 625-642.

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Richard J. Scott, AIA
Indoor Air Quality Architect

EMPLOYMENT AND EXPERIENCE

Clayton Environmental Consultants, Inc., Edison, New Jersey
Indoor Air Quality Architect, Indoor Air Quality, Environmental Health Services
April 1992

Drake & Scott Partnership, Mendham, New Jersey
Architects and Interior Designers
Principal/Architect
October 1981 to March 1992

Kuhn & Drake & Hessberger, PA, Summit, New Jersey
Architects and Interior Designers
Architect
September 1978 to October 1981

Prupac/Prudential Life Insurance Co., Holmdel, New Jersey
Space Planner, Office Planning & Design
March 1976 to September 1978

Mr. Scott is a registered architect and a registered professional planner with experience as a principal/project manager for corporate, governmental, educational, and food service building types and interiors. As project architect, he directed a team of designers and engineers through all phases of the design/construction process, including selection and installation of mechanical and electrical systems.

Mr. Scott performs indoor air quality evaluations including air sampling, HVAC system inspections, building envelope assessments, and preparation of proposals and reports. He is also involved in preconstruction indoor air quality plan review including evaluation of interior finishing and furnishing materials.

EDUCATION

Bachelor of Architecture, 1975
Pratt Institute
Brooklyn, New York

Construction Technology, 1971
State University of New York
Farmingdale, New York

PROFESSIONAL AFFILIATIONS

American Institute of Architects (AIA)

National Council of Architectural Registration Boards (NCARB)

2023860318

Frederick R. Swan, Jr., Ph.D., IHIT
Industrial Hygienist

EMPLOYMENT AND EXPERIENCE

Clayton Environmental Consultants, Inc., Edison, New Jersey
Industrial Hygienist, Indoor Air Quality, Environmental Health Services
April 1992
Industrial Hygiene Services
September 1988 to March 1992

West Liberty State College, West Liberty, West Virginia
Professor of Biology
September 1966 to May 1988

Dr. Swan performs indoor air quality evaluations, including air sampling for microbial, chemical, and other contaminants. He has also performed industrial hygiene assessments for toxic gases and vapors in a variety of industrial settings. He has a thorough understanding of state and federal environmental regulations relating to the workplace and employee exposure conditions. This knowledge helps Dr. Swan explain complex environmental issues to many clients and to develop recommendations so that they can improve indoor air quality.

He also has monitored work practices during asbestos removal projects and is proficient in determining airborne fiber concentrations by phase contrast microscopy (NIOSH 7400).

In addition to these skills, Dr. Swan has 22 years experience teaching college-level botany, general ecology, natural resources conservation, and introductory biology. He has published six articles on the ecology of forests and grasslands.

EDUCATION/CERTIFICATION

Ph.D., Natural Resources Conservation, 1966
Cornell University, Ithaca, New York

M.S., Occupational Health & Safety Engineering, 1988
West Virginia University, Morgantown, West Virginia

M.S. Botany, 1961
University of Wisconsin, Madison, Wisconsin

B.A., Biology, 1959
Middlebury College, Middlebury, Vermont

Industrial Hygienist in Training, ABIH, November 28, 1989
Sampling Technician, State of New York Department of Labor
Asbestos Safety Technician, State of New Jersey Department of Community Affairs
AHERA Building Inspector and Management Planner Accreditation

PROFESSIONAL AFFILIATIONS

American Industrial Hygiene Association
American Society of Safety Engineers
The Ecological Society of America
Association for Tropical Biology
Sigma Xi

2023860319

David E. MacPhaul
HVAC Engineer

EMPLOYMENT AND EXPERIENCE

Clayton Environmental Consultants, Inc., Edison, New Jersey
HVAC Engineer, Indoor Air Quality, Environmental Health Services
May 1989 to Present

Honeywell Sensors and Signal Processing Laboratory, Bloomington, Minnesota
Student Aid
1985 to 1989

Mr. MacPhaul has experience in indoor air quality research and evaluations, heating, ventilation, and air-conditioning (HVAC) systems analysis, and particulate filtration. He conducts indoor air quality evaluations in commercial and public buildings. His responsibilities include inspection and evaluation of HVAC systems, preparation of proposals and reports, and formulation of protocols for indoor air quality evaluations.

Aside from his consulting work, Mr. MacPhaul has developed software to automate recording and analysis of data for indoor air quality evaluations. He has assisted in the development and evaluation of membrane filtration systems for removal of airborne volatile organic compounds from aircraft HVAC systems. He has designed an environmental chamber to evaluate air cleaners, contaminant sensors, and strategies for contaminant and comfort control.

EDUCATION

Graduate Studies, Mechanical Engineering
University of Minnesota
Minneapolis, Minnesota

B.S., Mechanical Engineering, 1984
University of Massachusetts
Amherst, Massachusetts

PROFESSIONAL REGISTRATION

Fundamentals of Engineering (EIT Registration), 1986

PROFESSIONAL AFFILIATIONS

American Society of Heating, Refrigerating and Air-conditioning Engineers, Inc. (ASHRAE) -
Associate Member

Air and Waste Management Association - Associate Member

PUBLICATIONS

With P.R. Morey, *Rank Order Assessment of Volatile Organic Compounds in Indoor Air Quality Evaluations*. The 5th International Conference on Indoor Air Quality and Climate, Toronto, Ontario, Canada, July 1990.

With B. Krafthefer, *Ultrafine Particulate Emission from Baseboard and Other Resistance-Type Heaters*. The 5th International Conference on Indoor Air Quality and Climate, Toronto, Ontario, Canada, July 1990.

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